STAT

CLASSIFICATION RESTRICTED
SECURITY INFORMATION
CENTRAL INTELLIGENCE AGENCY
INFORMATION FROM
FOREIGN DOCUMENTS OR RADIO BROADCASTS

REPORT

CD NO.

COUNTRY	USSR	DATE OF INFORMATION	1952
SUBJECT	Scientific - Biology, plant physiology		
HOW PUBLISHED	Thrice-monthly periodical	DATE DIST.	6 Feb. 1953
WHERE PUBLISHED	Moscow	NO. OF PAGES	4
DATE PUBLISHED	1 Aug 1952		
LANGUAGE	Russian	SUPPLEMENT TO REPORT NO.	

THIS IS UNEVALUATED INFORMATION

SOURCE Doklady Akademii Nauk SSSR, Vol LXXXV, No 4, pp 913-916.

TRANSPORT ALONG THE PLANT OF CARBON DIOXIDE ABSORBED THROUGH THE ROOTS

A. L. Kursanov, N. N. Kryukova, B. B. Vartapetyan
Institute of Biochemistry imeni A. N. Bakh, Academy of Sciences USSR

/Figures referred to herein are not reproduced, but are available in the original document in the Library of Congress. Captions to figures are appended./

Since the time when the ability of green plants to assimilated carbon dioxide was discovered, the assumption has always been made that this gas is resorbed exclusively from the air. The possibility that CO_2 or carbonate could be taken up from the soil through the root system was neglected. Under the circumstances, the Stakhanovite yields obtained in agriculture puzzle physiologists, who are unable to explain how a 0.03% content of CO_2 in the air can produce such a vigorous growth of organic matter in large territories occupied by intensive agriculture.

Inadequate work on the utilization of CO_2 from the soil led to underestimation of the role played by humus in biological processes and also resulted in an inaccurate understanding of problems connected with the use of inorganic fertilizers. Warnings that the idea of exclusive nutrition of plants through the air may not be correct were regarded as conservative attempts to reinstate the discarded theory of humus nutrition. Insufficient attention has been paid to data obtained during the past 15-20 years to the effect that CO_2 may be resorbed through the roots.

Taking all this into consideration, we launched in 1951 a thorough investigation of the problem of carbon dioxide nutrition of plants through the root system. The preliminary experiments (1) already showed that 25-30 day-old kidney-bean plants, the roots of which have been immersed into a nutrient solution containing a small quantity of $NaHC^{14}O_3$, take up carbonate and transport it to the leaves and other parts of the plant where photosynthesis takes place under formation of products containing C^{14}, particularly of sugar.

CLASSIFICATION RESTRICTED

STATE	X	NAVY	X	NSRB		DISTRIBUTION	AEC			
ARMY	X	AIR	X	FBI						

STAT

The most reasonable assumption was that carbonates or free carbon dioxide are imbibed by the roots together with water, and that these compounds are carried up by the transpiration current to the leaves. To check the correctness of this assumption, we set up experiments in which both the quantity of carbon dioxide resorbed from the solution and the quantity of water taken up simultaneously by the same plant were determined. Typical results obtained in this manner are listed in Table 1 /tables referred to are appended/. Correlation of the values in question showed that the quantity of carbonate absorbed by the kidney-bean roots from the water is several times larger than that which would be expected on the basis of the volume of assimilated liquid. Assimilation by the roots of free CO_2 dissolved in water takes place still faster. All this indicates that assimilation of carbon dioxide entering through the roots is not directly connected with the assimilation of water and must be regarded as an independent process.

To determine the rate of motion /of the substances involved/, we used sodium carbonate and free carbon dioxide which contained C^{14}. In the case of the first substance, the roots of kidney-bean plants were immersed in an 0.02% Na_2CO_3 solution containing 0.5 μ of radioactive carbon per 10 ml; in the case of the second substance, the roots were placed into an enclosed atmosphere containing 3-5% CO_2 gas which had the same degree of radioactivity. In all experiments, measures were taken to prevent the diffusion of free $C^{14}O_2$ through the surrounding air to the leaves. During the whole experiment, the leaves were exposed to light, while the stalk was kept dark by shielding it with tin foil. At various time intervals, disks were cut from the upper pair of leaves with the aid of a cylindrical borer. These disks were tested for radioactive carbon by means of a counter. The results are illustrated in Table 2.

The values listed in Table 2 show that the rate of transportation of C^{14} in the plant is such that within a few minutes after contact between the roots and the carbonate solution has been established, the radioactive carbon isotope is detected in the upper pair of leaves, i. e., at a distance of 18-20 cm. from the roots. The rate of motion is still faster in the case of CO_2 gas. If the stalk of the plant contains chlorophyll (as it does in the case of the kidney bean), the major quantity of CO_2 is intercepted by the green cells of the stalk and does not reach the leaves. In case the stalk is shielded (i. e., kept in the dark), carbonates or carbon dioxide pass through it without interference. They are directed chiefly into the upper pair of leaves which have not yet opened completely, and only at a later time begin to accumulate in the lower, completely grown leaves. This is illustrated by the data in Table 3, which refer to two kidney-bean plants. The stalk of one of them was illuminated, and that of the other darkened by covering it with tin foil.

The accumulation of C^{14} in the illuminated stalk is shown in a still more striking manner in photographs showing radiation emitted by plants which have absorbed carbonate containing labeled carbon through the roots. It can be seen from Figure 1 that in the case of the normally /completely/ illuminated plant, the major part of heavy carbon accumulates in the roots and the middle part of the stalk, which is richest in chlorophyll. Above the middle part, C^{14} is detected only in insignificant quantities, particularly in the leaf petioles. If the middle part of the stalk is shielded from light, labeled carbon is not retained there, but reaches the leaves, where it accumulates in considerable quantities.

As judged from the photographs, carbonate and carbon dioxide that have been resorbed by the roots apparently move to the leaves along definite lines. These lines presumably correspond to vascular-fibrous bundles. The data of Table 3 and Figure 1 enable one to understand the biological significance of chlorophyll that is present in the stalks of many plants, where it develops regularly notwithstanding the low degree of adaptation of cutin-covered stalks to the utilization of CO_2 from the atmosphere. In the light of the experiments which have been described, the function of chlorophyll in the stalks must be assimilation of the carbon dioxide which enter through the roots. In this manner, the energy expended by the plant to move assimilated products from the leaves into other organs is undoubtedly reduced. Another very important circumstance connected with the presence of chlorophyll in stalks is formation of a considerable quantity of oxygen which is due to the assimilation of carbon dioxide that takes place in them. This oxygen is necessary to support the very intense respiration which is typical vascular-fibrous bundles.(2)

It has already been shown that resorption of CO_2 or carbonates by the roots proceeds independently of water resorption through the roots. At the same time, exposure of the leaves to light sharply increases the accumulation in all parts of the plant of carbon dioxide resorbed from the solution. This phenomenon must be regarded as due to a correlation between the functioning of the leaves and that of the root system. The underlying relationship is illustrated by the experiments represented schematically in Figure 2. In these experiments, the stalks of the plants were shielded from light.

The proportion of carbon dioxide taken up through the roots must vary with the conditions under which the plants exist and also with the species and age of the plants. We found that in experiments carried out in the laboratory with 9-15 day-old kidney-bean plants, one g of fresh roots absorbed during one h 2.4-4.4 mg of CO_2 from an atmosphere containing 0.8-1% CO_2. A carbon dioxide content of 0.8-1% corresponds to the average CO_2 content of the atmosphere of podzol soils. Carrying out calculations on the basis of the figures cited above, we found that 3-5 mg of CO_2 are lifted up to the leaves per 100 sq cm of leaf surface per hour. This is approximately 1/4 of the quantity of carbon dioxide that is resorbed by leaves from air if the photosynthesis is intensive.

BIBLIOGRAPHY

1. A. Kursanov, A. Kuzin, Ya. Mamul', DAN SSSR, Vol LXXIX, 1951, p 685.

2. A. Kursanov, M. Turkina, DAN SSSR, Vol LXXXIV, No 5, 1952.

Table 1. Absorption of Carbon Dioxide by Roots From a Solution and Absorption of Water. (in mg during 1 1/2 hr)

Source of CO_2	Kind of Plant	Content of CO_2 in 100 ml of Soln	CO_2 Absorbed	Water Taken up	Quantity of CO_2 Which Corresponds to the Water Taken Up	Ratio of CO_2 Calculated to CO_2 Absorbed
$NaHCO_3$	15-day-old kidney bean	31.4	1.6	220	0.07	1:23
$NaHCO_3$	15-day-old kidney bean	77.3	2.5	520	0.40	1:6
$NaHCO_3$	20-day-old sunflower	74.4	1.6	560	0.42	1:4
CO_2	15-day-old kidney bean [same?]	84.1	5.3	210	0.18	1:29

Declassified in Part - Sanitized Copy Approved for Release 2011/10/25 : CIA-RDP80-00809A000700100451-8

Table 2. Rate of Entry of C^{14} Into the Leaves of Kidney-Bean Plants Through the Roots (in impulses per min per disk cut from the leaves)

Time (min)	C^{14} Supplied in the Form of $Na_2C^{14}O_3$	C^{14} Supplied in the Form of $C^{14}O_2$
5	0	5
10	10	7
15	21	24
20	--	41
25	33	--
30	--	62

Table 3. Distribution of C^{14} in 15-Day-Old Kidney-Bean Plants Depending On the Illumination of the Stalk. Roots Immersed in a 0.025% Solution of $Na_2C^{14}O_3$; Duration of Experiment 3 hours. (impulses per min per 1 g of fresh plant)

	Stalk Exposed to Light	Stalk Darkened
Stalk	3,170	1,337
Lower Leaf	0	960
Middle Leaf	360	1,800
Upper Leaf	0	2,593

/Captions to figures follow./

Figure 1. Photographs Showing Radiation From 12-Day-Old Kidney-Bean Plants Which Received $Na_2C^{14}O_3$ Through the Roots for 2 Hours. A is a plant with a normally illuminated stalk, B a plant the stalk of which was shielded from light.

Figure 2. Effect of Light on the Accumulation of C^{14} From an $Na_2C^{14}O_3$ Solution by 10-Day-Old Kidney-Bean Plants. Duration of experiment 2 hrs. A: plant exposed to light - 4,800 impulses per min /due to radioactive carbon/ from the leaves, 192,500 impulses per min from the roots. B: plant kept in darkness - 152 impulses per min from the leaves, 6,390 impulses per min from the roots.

- E N D -